Criteria Pollutants — Metropolitan Area Trends

http://www.epa.gov/oar/airtrends/metro.html

Worth Noting

- Out of 296 metropolitan statistical areas, 36 have significant upward trends.
- Of these, only trends involving ozone had values over the level of air quality standards.

This chapter presents status and trends in criteria pollutants for metropolitan statistical areas (MSAs) in the United States. The MSA status and trends give a local picture of air pollution and can reveal regional patterns of trends. Such information can allow individuals to gauge the air pollution situation where they live. Not all areas in the country are in MSAs, and not all MSAs are included here. A complete list of MSAs and their boundaries can be found in the Statistical Abstract of the United States.[1] The status and trends of MSAs are based on four tables found in Appendix A (A-15 through A-18). Table A-15 gives the 2000 peak statistics for all MSAs, providing the status of that year. It also shows 10-year trends for the 263 MSAs having data that meet the trends requirements explained in Appendix B. Table A-16 lists these MSAs and reports criteria pollutant trends as "upward," "downward," or "not significant." These categories are based on a statistical test, known as the Theil test, described later in this chapter.

Another way to assess trends in MSAs is to examine Air Quality Index (AQI) values.[2,3,4] The AQI is used to present daily information to the public on one or more criteria pollutants in an easily understood format and in a timely manner. Tables A-17 and A-18 list the number of days with AQI values greater than 100 for the nation's 94 largest metropolitan areas (population greater than 500,000). Table A-17 lists AQI values based on all pollutants, and Table A-18 lists AQI values based on ozone alone. The tables listing Pollutant Standards Index (PSI) data from previous reports may not agree with the tables in this report because of the new way to calculate the AQI. These changes are presented in more detail later in this chapter.

A new technique for displaying air quality information is also described. This technique presents visual clues as to the status of different MSAs.

Not every MSA appears in these tables. Some do not appear because the population is so small or the air quality is so good that AQI reporting is not currently required. Ambient monitoring for a particular pollutant may not be conducted if there is no problem, thus some MSAs have no ongoing air quality monitoring for one or more of the criteria pollutants. In addition, there are also MSAs with too little monitoring data for trends analysis purposes (see Appendix B).

Status: 2001

The air quality status for MSAs is provided in Table A-15, which lists peak statistics for all criteria pollutants measured in an MSA. As discussed above, not all criteria pollutants are measured in all MSAs, hence the "ND" (no data) listings in Table A-15. Examining Table A-15 shows that 140 areas had peak concentrations exceeding standard levels for at least one criteria pollutant. The number of these areas increased by 4 the count from 2000 (136 areas). These 140 areas are home to 56 percent of the U.S. population. Similarly, there were 60 areas (with 36 percent of the population) that had peak statistics that exceeded two or more standards. Six areas—Bakersfield, CA, Riverside–San Bernardino, CA, Fresno, CA, Birmingham, AL, St. Louis, MO, and Visalia–Tulare–Porterville, CA (with 3 percent of the U.S. population)—had peak statistics from three pollutants that exceeded the respective standards. There was one area that violated four or more standards (St. Louis, MO).

Trends Analysis

Table A-16 displays air quality trends for MSAs. The data in this table are average statistics of pollutant concentrations from the subset of ambient monitoring sites that meet the trends criteria explained in Appendix B. A total of 246 MSAs have at least one monitoring site that meets these criteria. As stated previously, not all pollutants are measured in every MSA. From 1992 to 2001, statistics based on the standards were calculated for each site and pollutant with available data. Spatial averages were obtained for each of the 246 MSAs by averaging these statistics across all sites in an MSA. This process resulted in one value per MSA per year for each pollutant. Although there are seasonal patterns of high values for some pollutants in some locations, the averages for every MSA and year provide a consistent indicator with which to assess trends.

Table 3-1. Summary of MSA Trend Analyses by Pollutant, 1990–1999

	Trend Statistic	Total # MSAs	# MSAs Up	# MSAs Down	# MSAs with No Significant Trend
CO	Second max. 8-hour	134	0	104	30
Pb	Max. quarterly mean	35	1	12	22
NO_2	Arithmetic mean	97	3	37	57
O_3	Fourth max. 8-hour	202	17	10	175
O_3	Second daily max. 1-hour	202	12	15	175
PM_{10}	Ninetieth percentile	164	4	41	119
PM_{10}	Weighted annual mean	164	7	60	97
SO_2	Arithmetic mean	139	4	70	65
SO_2	Second max. 24-hour	139	2	62	75

Because air pollution levels are affected by variations in meteorology, emissions, and day-to-day activities of populations in MSAs, trends in air pollution levels are not always well defined. To assess upward or downward trends, we applied a statistical significance test to these data. An advantage of using the statistical test is the ability to test whether or not the upward or downward trend is real (significant) or just a chance product of year-to-year variation (not significant). Because the underlying pollutant distributions do not meet the usual assumptions required for common significance tests, the test was based on a nonparametric method commonly referred to as the Theil test.[5,6,7,8] By using linear regression to estimate the trend from changes during the entire 10-year period, we can detect an upward or downward trend even when the concentration level of the first year equals the concentration level of the last year.

Table 3-1 summarizes the trend analysis performed on the 246 MSAs. It shows that there were no upward trends in carbon monoxide (CO). PM_{10} and sulfur dioxide had upward trends in 7 MSAs over the past decade, NO_2 had upward trends in 3 MSAs, while SO_2 had upward trends in 4 MSAs. Lead had an upward trend in 1 MSA. Further examination of Table A-16 shows that, of the 246 MSAs, (1) 180 had downward trends in at least one of the criteria pollutants, (2) 36 had upward trends (of these 36, 25 also had downward trends in other pollutants, leaving 9 MSAs with exclusively upward trends), and (3) only 2 MSAs had no significant trends. A closer look at the 36 MSAs with upward trends reveals that 13 were exceeding the level of the 8-hour ozone standard, and 3 were above the 1-hour standard. For all other pollutants with upward trends in any MSA, the levels observed were well below standard levels. Taken as a whole, these results still demonstrate significant improvements in urban air quality over the past decade for the nation; however, the number of MSAs with upward trends is increasing when compared to numbers in previous reports.

The Air Quality Index

The AQI provides information on pollutant concentrations for ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. Formerly known as the PSI, this nationally uniform air quality index is used by state and local agencies for reporting daily air quality to the public. In 1999, EPA updated the AQI to reflect the latest science on air pollution health effects and to make it more appropriate for use in contemporary news media, thereby enhancing the public's understanding of air pollution across the nation. Currently, the AQI may be found in national media such as *USA Today* and on the Weather Channel, as well as in local newspapers and broadcasts across the country. It also serves as a basis for community-based programs that encourage the public to take action to reduce air pollution on days when levels are projected to be of concern. An Internet Web site, AIRNOW **(http://www.epa.gov/airnow)**, which presents "real time" air quality data and forecasts of summertime smog levels for most states, uses the AQI to communicate information about air quality. The index has been adopted by many other countries (e.g., Mexico, Singapore, and Taiwan) and is used around the world to provide the public with information on air pollutants.

AQI values for each of the pollutants are derived from concentrations of that pollutant. The index is "normalized" across each pollutant so that, generally, an index value of 100 is set at the level of the short-term, health-based standard for that pollutant. An index value of 500 is set at the significant harm level, which represents imminent and substantial endangerment to public health.[9] The higher the index value, the greater the level of air pollution and health risk.

To make the AQI as easy to understand as possible, EPA has divided the AQI scale into six general categories that correspond to a different level of health concern:

- **Good** (0–50): Air quality is considered satisfactory, and air pollution poses little or no risk.
- **Moderate** (51–100): Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of individuals. For example, people who are unusually sensitive to ozone may experience respiratory symptoms.
- **Unhealthy for Sensitive Groups** (101–150): Certain groups of people may be particularly sensitive to the harmful effects of certain air pollutants. This means they are likely to be affected at lower levels than is the general public. For example, people with respiratory disease are at greater risk from exposure to ozone, while people with respiratory disease or heart disease are at greater risk from particulate matter. When the AQI is in this range, members of sensitive groups may experience health effects, but the general public is not likely to be affected.
- **Unhealthy** (151–200): Everyone may begin to experience health effects. Members of sensitive groups may experience more serious health effects.
- **Very Unhealthy** (201–300): Air quality in this range triggers a health alert, meaning everyone may experience more serious health effects.
- **Hazardous** (over 300): Air quality in this range triggers health warnings of emergency conditions. The entire population is more likely to be affected.

Because different groups of people are sensitive to different pollutants, there are pollutant-specific health effects and cautionary statements for each category in the AQI.

An AQI report will contain an index value, category name, and the pollutant of concern and is often featured on local television or radio news programs and in newspapers, especially when values are high. For national consistency and ease of understanding, if the AQI is reported using color, there are specific, required colors associated with each category. Examples of the use of color in AQI reporting include the color bars that appear in many newspapers and the color contours of the ozone map. The six AQI categories, their respective health effects descriptors, colors, index ranges, and corresponding concentration ranges are shown in Table 3-2. EPA has also developed an AQI logo (Figure 3-1) to increase the awareness of the AQI in media reports and also to indicate that the AQI is uniform throughout the country.

The AQI integrates information on pollutant concentrations across an entire monitoring network into a single number that represents the worst daily air quality experienced in an urban area. For each of the pollutants, concentrations are converted into index values between 0 and 500. The level of the pollutant with the highest index value is reported as the AQI level for that day. There is a new AQI requirement to report any pollutant with an index value above 100. In addition, when the AQI is above 100, a pollutant-specific statement indicating what specific groups are most at risk must be reported. For example, when the index value is above 100 for ozone, the AQI report will state "children and people with asthma are most at risk." The AQI must be reported in all MSAs with air quality problems and populations greater than 350,000 according to the 2000 census. Previously, urbanized areas with populations greater than 200,000 were required to report the index.

Table 3-2. AQI Categories, Colors, and Ranges

Category	AQI	O_3 (ppm) 8-hour	O_3 (ppm) 1-hour	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)
Good	0–50	0.000–0.064	([b])	0.0–15.4	0–54	0.0–4.4	0.000–0.034	([c])
Moderate	51–100	0.065–0.084	([b])	15.5–40.4	55–154	4.5–9.4	0.035–0.144	([c])
Unhealthy for Sensitive Groups	101–150	0.085–0.104	0.125–0.164	40.5–65.4	155–254	9.5–12.4	0.145–0.224	([c])
Unhealthy	151–200	0.105–0.124	0.165–0.204	65.5–150.4	255–354	12.5–15.4	0.225–0.304	([c])
Very unhealthy	201–300	0.125–0.374	0.205–0.404	150.5–250.4	355–424	15.5–30.4	0.305–0.604	0.65–1.24
Hazardous	301–400	([a])	0.405–0.504	250.5–350.4	425–504	30.5–40.4	0.605–0.804	1.25–1.64
	401–500	([a])	0.505–0.604	350.5–500.4	505–604	40.5–50.4	0.805–1.004	1.65–2.04

[a] No health effects information for these levels—use 1-hour concentrations.
[b] 1-hour concentrations provided for areas where the AQI is based on 1-hour values might be more cautionary.
[c] NO_2 has no short-term standard but does have a short-term "alert" level.

Figure 3-1. Air quality index logo.

Summary of AQI Analyses

Of the five criteria pollutants used to calculate the AQI, only four (CO, O_3, PM_{10}, and SO_2) generally contribute to the AQI value. In recent years, nitrogen dioxide has never been the highest pollutant measured because it does not have a short-term standard and can be included only when the index reaches a value of 200 or greater. Ten-year AQI trends are based on daily maximum pollutant concentrations from the subset of ambient monitoring sites that meet the trends requirements in Appendix B.

Because an AQI value greater than 100 indicates that at least one criteria pollutant has reached levels at which people in sensitive groups are likely to suffer health effects, the number of days with AQI values greater than 100 provides an indicator of air quality in urban areas. Figure 3-2 shows the trend in the number of days with AQI values greater than 100 summed across the nation's largest metropolitan areas. This number is expressed as a percentage of the days in the first year (1992). Because of their magnitude, AQI totals for Los Angeles, CA, Riverside, CA, Bakersfield, CA, Ventura, CA, Orange County, CA, and San Diego, CA, are shown separately as California. Plotting these values as a percentage of 1992 values allows trends of different magnitudes to be compared on the same graph. The long-term air quality improvement in California urban areas is evident in this figure. Between 1992 and 2001, the total number of days with AQI values greater than 100 decreased more than 50 percent. The variability in the remaining major cities across the United States makes it difficult to interpret the change over the same period (labeled as "rest" in Figure 3-2), though it does appear to be rising. Other areas that had serious, severe, or extreme ozone problems (labeled as "pams" in Figure 3-2) show almost no change.

Although five criteria pollutants can contribute to the AQI, the index is driven mostly by ozone. AQI estimates depend on the number of pollutants monitored as well as the number of monitoring sites where data are collected. The more pollutants measured and the more sites that are available in an area, the better the estimate of the AQI for a given day. Historically, ozone accounts for the majority of days, with AQI values above 100. Soon, $PM_{2.5}$ will also be monitored and reported on a regular basis, which will reduce the percentage of days that ozone is the greatest AQI pollutant. Table A-18 shows the number of days with AQI values greater than 100 that are attributed to ozone alone. Comparing Tables A-17 and A-18, the number of days with an AQI above 100 are increasingly due to ozone. In fact, the percentage of days with an AQI above 100 due to ozone have increased from 94 percent in 1992 to 98 percent in 2001 (Figure 3-3). This increase reveals that ozone increasingly accounts for those days above the 100 level and, therefore, reflects the success in achieving lower CO and PM_{10} concentrations. However, the typical 1-in-6 day sampling schedule for most PM_{10} sites limits the number of days that PM_{10} can factor into the AQI determination, which may, in some places, account for the predominance of ozone. In the future, $PM_{2.5}$ may challenge ozone as the dominant pollutant.

A New Display Technique

As more and more information about air pollution and its effect on our health is being presented to the public through various media channels, a need has arisen to provide the general public with a simple, visual method for assessing the degree of air pollution in their communities. To meet this need, EPA is exploring a new technique for displaying air quality information that is designed to allow the general public to quickly and easily review the degree of air pollution in the 319 MSAs across the United States. This technique would

Figure 3-2. Number of days with AQI values >100, as a percentage of 1990 value.

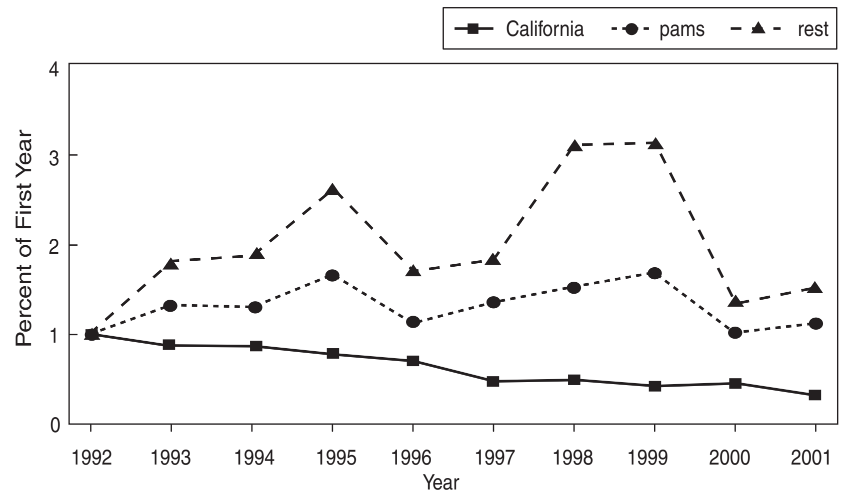
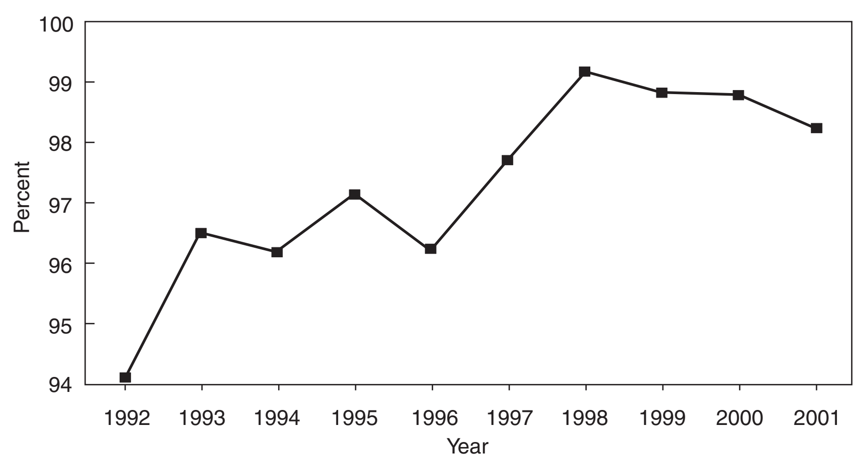


Figure 3-3. Percentage of days over 100 due to ozone.

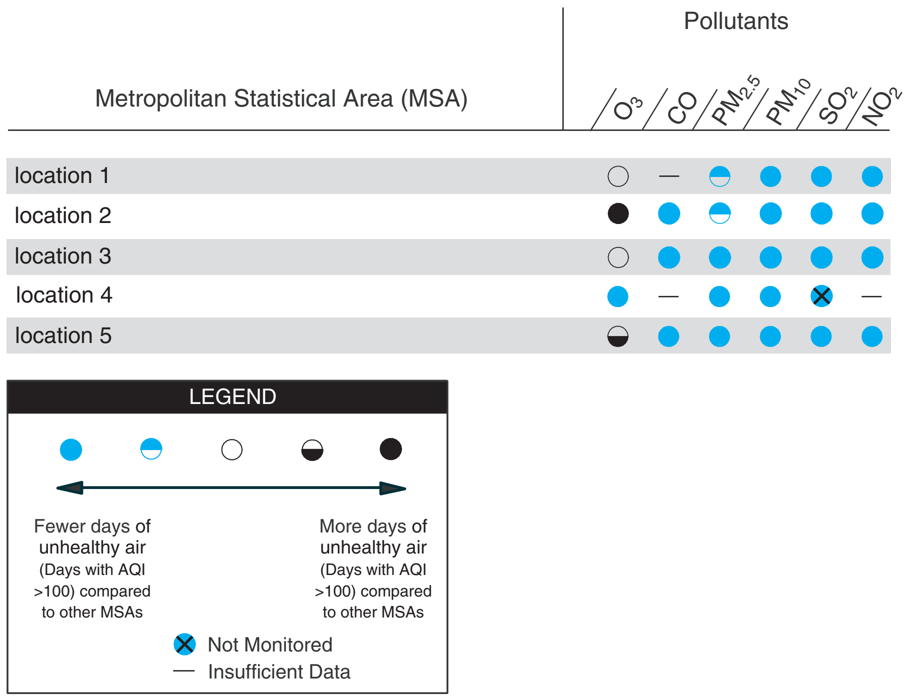


use color-coded circles to show levels of each criteria pollutant in each MSA relative to its levels in the other MSAs. A solid blue ● indicates fewer days of unhealthy air (meaning that MSA had fewer AQI days over 100 for, say, ozone than most of the other MSAs had for ozone). On the other end of the spectrum, a black ● indicates more days of unhealthy air.

Figure 3-4 presents an example of how this new display technique might appear. The legend in Figure 3-4 explains how the color-coded symbols could be used to quickly and easily provide information about air quality and air pollutants. The new display technique would not provide new or additional air quality data, nor would it be used as a rating system or show trends in air quality over time. Rather, its purpose would be to provide a simplified, visual tool for interpreting air quality information in selected MSAs for a specific year for each of the selected pollutants. EPA is continuing to assess the feasibility of the new technique and to explore additional capabilities that might be added, such as a Web-based application that would allow users to sort and query information to generate customized reports about health-related air quality issues, as well as components relating to multiyear displays and visibility.

Additional information on this new display technique is presented in a discussion paper in the Special Studies section of this report.

Figure 3-4. Sample from the new display technique.



References and Notes

1. *Statistical Abstracts of the United States, 2000,* U.S. Department of Commerce, U.S. Bureau of the Census.

2. *Air Quality Index, A Guide to Air Quality and Your Health,* EPA-454/R-00-005, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, June 2000.

3. *Code of Federal Regulations,* 40 CFR Part 58, Appendix G.

4. *Guideline for Reporting of Daily Air Quality—Air Quality Index (AQI),* EPA-454/R-99-010, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, July 1999.

5. *Note*: Although the results are summarized in the report for comparison purposes, the intent of publishing Tables A-16 through A-18 is to present information on a localized basis, to be used on a localized basis (i.e., one MSA at a time). Therefore, no attempt was made to adjust the Type I error to a table-wide basis. All the tests for trends were conducted at the 5 percent significance level. No inference has been made from the tables as a whole.

6. T. Fitz-Simons and D. Mintz, *Assessing Environmental Trends with Nonparametric Regression in the SAS Data Step*, American Statistical Association 1995 Winter Conference, Raleigh, NC, January, 1995.

7. Freas, W.P. and E.A. Sieurin, *A Nonparametric Calibration Procedure for Multi-Source Urban Air Pollution Dispersion Models*, presented at the Fifth Conference on Probability and Statistics in Atmospheric Sciences, American Meteorological Society, Las Vegas, NV, November 1977.

8. M. Hollander and D.A. Wolfe, *Nonparametric Statistical Methods*, John Wiley and Sons, Inc., New York, NY, 1973.

9. Based on the short-term standards, federal episode criteria, and significant harm levels, the AQI is computed for PM (particulate matter), SO_2, CO, O_3, and NO_2. Lead is the only criteria pollutant not included in the index because it does not have a short-term standard, federal episode criteria, or significant harm level.